

**U.S. UTILITY PATENT APPLICATION**

**METHOD AND APPARATUS FOR PRINTING INK IMPRINTED INDICIA**

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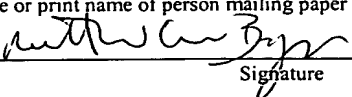
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# **METHOD AND APPARATUS FOR PRINTING INK IMPRINTED INDICIA**

**John Finger and Baron Youn**

## **RELATED APPLICATIONS**

[001]                    This application claims priority United States Provisional Patent Application serial number 60/409,353 filed on September 9, 2002 and is incorporated herein by reference.

## **BACKGROUND OF THE INVENTION**

[002]                    The present invention relates to a method and apparatus for imprinting an indelible ink image upon a selected substrate. Such indelible ink images are particularly desirable for use in imprinting any informational images, such as a scannable bar code, upon selected substrates that are exposed to unusually harsh environments as in industrial applications. Although the following discussion uses scannable bar codes as an example of the particular usefulness of the present invention, it is to be understood that the method and apparatus taught herein may be used on any suitable substrate and for the imprinting of other useful indicia such as sequential numbering, operating data, warning notices, etc. where long life legibility of the imprinted material is required.

[003]                    Many devices exist for reading bar codes printed on packages and other objects. Bar codes may be printed on retail merchandise for product and price identification at the point of sale, warehouse inventory control, process control, and many other applications

[004]                    The basic principle employed in bar code reading devices is the detection of contrasting reflected light. A source of illumination such as a low powered helium neon laser, produces a beam of light which is may be moved across the

bar code imprint. Dark areas (bars) absorb laser light, whereas light areas (spaces) reflect light that is detected by a scanner.

[005] Optics are typically used to expand the laser beam into a line of laser light and to move the expanded laser beam across the area containing the bar code. Without the use of optics, the laser beam would only appear as a point of light. This process is commonly referred to as "moving-beam scanning." As the moving beam travels across the area to be scanned for a code, commonly called the scanning zone, the light and dark transition areas are detected and converted to a digital signal known as the code. A typical bar code consists of a defined number of light and dark transition areas having given ratios between the wide and narrow intervals.

[006] Thus a scanable bar code consists of a series of solid parallel bars separated by open spaces. The bars and spaces are printed at either a full width or half width. The bars and spaces signify a bit pattern wherein wide spaces or bars are assigned a "one" while narrow spaces and bars are assigned a "zero" (or vice versa).

[007] Prior art patent no. 3,728,677 employs a mirrored wheel having a polygonal periphery. Rotation of the mirrored wheel scans a laser beam across two azimuthally spaced mirrors, which deflect the beam downwardly to trace an "X" shaped pattern.

[008] It is also known to use prisms and mirrors, or other apparatus, to turn the scanning beam direction of an optical code scanning system. For example see U.S. Pat. Nos. 3,663,800; 3,774,014; 3,800,282; 3,902,047; and 4,064,390.

[009] U.S. Pat. No. 3,906,203 teaches scanning a bar code and measuring its interval widths by recording the time required to traverse each interval. The successive interval widths are then multiplied by a constant such as three, five, or eight. By storing and comparing the multiplied widths of successive scans, the scanner can determine whether the latest interval is about the same size as, or much smaller, or larger, than, the prior interval.

[010] From the above description of bar codes, their formats and how they function, it is understandable that for a bar code system to function accurately it is desirable that the bar code, printed upon the object being scanned, contain clear undistorted set of dark and light parallel lines or bars. However, in many industrial applications and uses, the imprinted bar codes may be damaged by abrasion, chemicals, solvents and/or heat to the extent that the bar code or portions thereof maybe obliterated or otherwise unreadable.

[011] Accordingly there is a need for a method and apparatus for imprinting a durable bar code that will resist the harsh environment of the industrial workplace.

### **SUMMARY OF THE INVENTION**

[012] In accord with the present invention a method and apparatus is taught by which a durable bar code, and/or any other printed material, may be applied to a suitable substrate material, which may then be adhesively affixed to or fastened by means of an alternative method to any product or article.

[013] The Sony Chemical Corporation of America has developed a proprietary radiation-curable printing ink and a method of thermally transferring such ink from an ink ribbon to a selected substrate which is the subject of United States Patent Nos. 6,476,840 and 5,729,272 incorporated herein by reference.

[014] By the present invention a substrate having printed thereon a bar code, and/or any other information bearing image, using inks curable by application of UV light is subjected to a combination of IR and UV energy whereby the ink, on the printed image, is cross-linked thereby producing a durable printed image.

[015] Using an elliptical reflector the light energy from a UV light source is convergingly directed to a focal point. However by the present invention, the substrate having an image printed thereon, using a UV curable ink, is passed through the focused UV radiation zone above the reflected light's focal point.

Thus the UV curable ink image printed upon the substrate is cured by being exposed to the combination of UV and IR energy emitted from the UV light source.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

- [016]                Figure 1 presents a pictorial view of apparatus for processing a continuous roll of ink imprinted labels by the present invention.
- [017]                Figure 2 presents a pictorial view of apparatus for processing individual ink imprinted cut sheet labels by the present invention
- [018]                Figure 3 presents a schematic depiction of the apparatus illustrated in figure 1.
- [019]                Figure 4 presents a schematic depiction of the apparatus illustrated in figure 2.
- [020]                Figure 5 presents a schematic depiction of an additional embodiment of the present invention comprising a two step process.
- [021]                Figure 5A generally presents a schematic depiction of the two step system as illustrated in figure 5 wherein the UV energy source and its associated elliptical reflector has been replaced by a remote UV energy source and a liquid filled light guide.
- [022]                Figure 5B schematically presents the system as illustrated in figure 5A wherein the thermal transfer printing apparatus and the UV curing apparatus have been combined into one printing unit.
- [023]                Figure 6 presents an isolated crosssectional schematic of the UV ink curing system in accord with the present invention.

[024] Figure 7 presents an isolated crossectional view of an alternate embodiment of the elliptical reflector as illustrated in figures 3, 4, and 5 comprising a two piece reflector that may be closed about the UV light source.

[025] Figure 8 presents a crossectional view of the two piece reflector illustrated in figure 7 wherein the two halves of the elliptical reflector are rotated to enclose the UV light source.

[026] Figure 9 presents a flow chart of the method practiced by the present invention.

[027] Figure 10 presents an electrical schematic of the power supply for the apparatus illustrated in figures 1 and 2.

[028] Figure 11 presents an electrical schematic for the embodiment illustrated in figure 1.

[029] Figure 12 presents an electrical schematic for the powering the UV energy source.

## **DETAILED DESCRIPTION OF THE INVENTION**

[030] Referring to figure 1 and 3, the apparatus 10 for practicing the present invention comprises a thermal transfer label printing station 12 and an ink curing station 14. Within printing station 12 a continuous label carrier film 15 having blank, removable labels 16, or any other printable substrate material, removably affixed thereto, is supplied from feed roll 21. Print head 22 transfers ink from ink ribbon 18 upon labels 16 in a desired pattern as labels 16 pass thereby. Ink imprinted labels 19 then pass from printing station 12 and into curing station 14 wherein imprinted labels 19 are subjected to a focused, ultraviolet light emitted from an ultraviolet light source 25 focused by elliptical reflector 26. The combined IR and UV radiation emitted from ultraviolet light source 25 causes

curing of the radiation curable thermal ink imprinted image on labels 19 as discussed in more detail below.

[031] For a more detailed description of the ink used and the process of thermally transferring an inked image from ribbon 18 to labels 16 the reader is referred to United States Patent Nos. 5,729,272 and 6,476,840 both of which are incorporated herein by reference.

[032] As carrier film 15, having ink imprinted labels 19 thereon, pass through ink curing station 14, carrier film 15 is supported upon and carried upon endless belt 30 driven by rotating drive rollers 32A and 32B by motor means not shown. A vacuum pump 31 is provided to maintain a negative pressure across tables 34A and 34B to draw carrier film 15 down upon the tables. As carrier film 15 and ink imprinted labels 19 pass through the radiation zone 32, carrier film 15 is supported upon fixed tandem tables 34A and 34B. Tables 34A and 34B act to dimensionally fix the distance between UV light source 26 and ink imprinted labels 19 as they pass through the radiation zone 32. It is to be noted that ink imprinted labels 19 are oriented to pass above the focal point 35 of the UV light reflected from elliptical reflector 26 as illustrated in figure 3.

[033] After curing of ink imprinted labels 19 within radiation zone 32, the cured labels 23 are permitted to cool prior to being wrapped upon receiving roll 36. Depending upon the exact configuration and structure of curing station 14 it may be preferred to provide covered exit and entrance conduits 38A and 38B respectively, as UV radiation shields.

[034] Although figures 1 and 3 illustrates a continuous feed label curing system wherein blank labels are feed from supply roll 21, imprinted with a UV curable ink, subjecting the imprinted UV curable ink to UV energy wherein the UV curable ink is fully cross-linked, and subsequently wound upon a receiving roll 36, figures 2 and 4 presents an alternate embodiment of the process wherein preprinted, cut sheet type labels 19A may be separately feed into the ink curing station 14A manually or by any other suitable mechanical means not shown.

[035] Ink curing station 14A generally comprises a porous web type endless belt 30 supported upon support tables 34A and 34B (similar as that illustrated in figure 3). Ink imprinted labels 19A are placed upon belt 30, manually or by any suitable mechanized means, whereupon labels 19A are passed through radiation zone 32 wherein the UV curable ink is fully cured. The fully cured labels 23A may then be collected by any suitable means not shown.

[036] A further embodiment of the process illustrated in figure 5 may comprise a two step process wherein the ink imprinted labels, as they exit printing unit 12, are received directly upon a receiving roll 24 as opposed to being directly feed into curing station 14. The roll of ink imprinted labels 24 may then be feed into an ink curing station 14 at a later time.

[037] Illustrated in figure 5A is a further alternative embodiment of the ink curing station identified as element 50. In ink curing station 50 the UV light source 25 and its associated elliptical reflector 26, illustrated in figure 5, has been replaced by a remote UV energy source 52 having a UV energy delivery medium such as a flexible, liquid filled light guide 54. UV energy transmitted from remote source 52, through light guide 54 is received within light discharge unit 62 and thereafter passed through an appropriate focusing lens 56 whereby a focused UV radiation field 58, similar to radiation field 32 in figure 5, is directed to focal point 25.

[038] Similarly figure 5B presents an additional embodiment, of the present invention, wherein the thermal printing apparatus 22 and the UV curing apparatus has been combined into a unitary printing device 60. Although the embodiment illustrated in figure 5B illustrates use of a remote UV energy source 52 and its associated light pipe 54, it is to be understood that the figure 5B embodiment may also be structured to use the elliptical reflector 26 and UV light source 25 as illustrated in

[039] However, because of the remote location of UV energy source 52 and/or of the possibility the remote UV energy source may include an IR filter, it may be necessary to provide a preheater 59 to raise the temperature of the imprinted

ink above ambient temperature to assist the curing process as described further below.

[040] Although the above embodiment employing a remote UV energy source is described as being an alternate embodiment of the figure 5 two step process, it is to be understood that the remote UV energy source described in figure 5A may also be used in place of the elliptical reflector embodiments illustrated in the other figures.

[041] Referring now to figure 6, UV energy source 25 is positioned within elliptical reflector 26 such that the reflected UV light rays 38 are directed to a common focal point 35. However, to affect curing of the imprinted UV curable ink it has been discovered preferable to pass ink imprinted labels 19 through the radiation field 32 above, and not through, focal point 35 as illustrated. The concentration of UV energy at focal point 35 has been found to be too intense and very likely to cause ignition of labels 19. By passing ink imprinted labels 19 through radiation field 32, above focal point 35, the amount of UV energy, per surface area, of the label 19, may be selectively chosen to labels 19.

[042] Since the UV energy imparted to and absorbed by the ink imprinted label, is dependent upon many variables, such as, the UV light 25, surface area of the label, ink composition, ink color, line speed, substrate material parameters, etc., a quantitative value for the distance H above focal point 35 is not possible. The distance H must be determined qualitatively by empirical techniques for a given situation.

[043] In the configuration illustrated in figure 6 wherein imprinted labels 19 are passed through radiation zone 32 above focal point 35 the UV curable ink imprinted upon the label substrate is dry and at ambient temperature. In order to effectively cross-link the UV curable ink imprinted upon labels 19 it is preferable to elevate the imprinted ink substantially above ambient temperature so that the UV energy may affect cross-linking of the ink composition. In the process configuration as illustrated in figure 6 the inherent IR energy accompanying the UV energy from UV light source 25 has been found to

adequately elevate the imprinted ink temperature for this purpose. Here again quantitative values relating to the configuration illustrated in figure 6 are not feasible for reasons stated immediately above. However one must optimize the amount of IR and UV energy, per surface area of label 19, by experimentation considering all variables affecting the substrate and the ink printed thereon.

[044]                Alternatively one may consider passing an ink imprinted substrate 19A through the extended radiation field 41 at a distance L beyond focal point 35. However since IR energy decreases more quickly than UV energy as a function of distance from its source, optimizing the level of IR and UV energy received upon imprinted substrate 19A from UV light source 25 becomes a problem without adding means for preheating the imprinted ink on substrate 19A as it approaches radiation field 41. Such a preheating device 42 is schematically illustrated in figure 6. Preheater 42 may comprise a thermal convection heater, an IR heater, or any other suitable heating means. However, now one must optimize both the IR and UV energy received by substrate 19A and the energy received from preheater 42.

[045]                It is to be also considered that a preheater, such as preheater 42 may also be used to preheat substrate 19 in figure 6.

[046]                It is to be understood that because of the massive heat generation by the UV light source 25 within the close confines of the apparatus as schematically illustrated herein it is necessary to provide adequate circulating cooling air within the UV apparatus schematically illustrated as cooling fan 22 in figures 1 through 5.

[047]                Referring now to figures 7 and 8, a two piece elliptical reflector 50 is illustrated. As illustrated, elliptical reflector 50 generally comprises a left half 52 and a right half 54. Each reflector half, 52 and 54 may be pivoted about pivot points 62 and 64 respectively whereby reflector halves 52 and 54 may be rotated so as to act as shutters that enclose UV light source 25 as illustrated in figure 8.

[048] Having operable shutters that may be closed about UV light source 25 is particularly useful when the operator desires to stop the machine throughput but does not desire to totally turn off UV light source 25, or if the desired line speed is otherwise sensed to diminish or stop for unanticipated causes. By closing shutters 52 and 54, about UV light 25, IR and UV radiation is prevented from reaching labels 19 and possibly causing the labels to catch fire within the machine. Similarly should the operator need to stop the machine for maintenance and/or substrate change over, the operator may reduce the power to UV light 25 to a lower level without completely turning the UV light off whereby less time will be necessary for restart.

[049] Figure 9 presents a flow chart of the method steps performed by the apparatus illustrated in figures 1 and 3 in accord with the present invention. The process begins by first preparing a suitable substrate upon which the imprinted image is desired which generally, but not necessarily, comprises a continuous roll of paper labels or cut sheet paper stock. Next an UV curable ink imprinted image is printed upon the chosen substrate. It is then preferred to raise the temperature of the imprinted ink to a level above ambient temperature thereby causing the ink to flow slightly and more securely adhere to the substrate followed immediately by subjecting the softened ink to an UV radiation field whereby the softened ink is caused to cross-link into a hardened, durable substance. These two steps may be performed separately or may be preformed simultaneously. After curing of the ink is accomplished, the imprinted ink is permitted to cool and subsequently collected on a receiving roll or any other appropriate device.

[050] Figure 10 presents an electrical schematic of the 120 volt power supply for the apparatus illustrated in figures 1 and 2. Since the electrical schematic of figure 10 is self explanatory, no further explanation is deemed necessary here.

[051] Figure 11 presents an electrical schematic for the embodiment illustrated in figure 1. Again as the electrical schematic in figure 11 is self explanatory, no further explanation is deemed necessary here.

**[052]** Figure 12 presents an electrical schematic for the powering the UV energy source. Since the electrical schematic of figure 12 is self explanatory, no further explanation is deemed necessary here.

**[053]** Although the invention has been described in detail with reference to the illustrated embodiments, variations and modifications exist within the scope and spirit of the invention as described and defined in the following claims.